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EFFECT OF INTEGRATED ORGANIC AND INORGANIC FERTILIZER ON NUTRIENT UPTAKE BY RICE

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Abstract

A field experiment was conducted to assess the effects of integrated use of urea with cowdung, poultry manure and urban wastes in boro rice (Var.BRRIdhan29) at the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during 2008-2009. Urea at the rate of 47.5 kg N/ha (50% of recommended N) along with PKS and cowdung, poultry manure or urban wastes at the rates of 11.5, 9.5 or 11.8 t/ha, respectively resulted in better nutrient uptake by grain or straw compare to urea alone, but the effect of poultry manure was the most pronounced than that of cowdung and urban wastes. Soil pH value decreased slightly as compared to that of initial soil. Application of urea-nitrogen alone slightly decreased the organic matter, total N and available P contents. The overall results indicate that urea nitrogen at the rate of 47.5 kg/ha along with PKS and 9.5 t poultry manure/ha was the best treatment for higher sustainability of soil fertility.

Introduction

Bangladesh soils have been depleted with several essential nutrients mainly because of intensive cultivation having no return from organic recycling. Fertilizers are indispensable for the crop production systems of modern agriculture and inorganic fertilizers today hold the key to success of the crop production systems of Bangladesh agriculture, being responsible for about 50% of the total production (FRG, 2005). But, it is also true that maintaining the sustainable crop production is difficult by using chemical fertilizers alone or using organic manure only (Bair, 1990).

The combined use of organic manures and inorganic fertilizer might be helpful for sustainable crop production and maintenance of soil fertility. Nambiar (1991) also reported that integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining higher soil fertility status.

Cowdung, a common manure in Bangladesh, can play a vital role in soil fertility improvement as well as in supplying most of the macro and micronutrients. BRRI researchers reported that inclusion of cowdung at the rate of 5 t/ha/year improved the rice productivity as well as prevented the soil resources from the degradation (Bhuiyan, 1991).

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In the recent years, poultry farms of the different sizes have been established all over the country. Poultry farm holders use concentrated feeds to feed their poultry birds. As a result the poultry excreta are rich in nutrients. As the poultry excreta are not used as fuel, these can be the good source of nutrients for field crops. Urban wastes products generally available and is not used widely due to lack of knowledge but it can be used for crop production.

Despite the fact that the soil fertility research in Bangladesh has been carried out for long time but the cropping pattern based fertilizer research is relatively scarce to evaluate the effect of integrated use of urea with cowdung, poultry- manure, urban wastes on the yield and nutrient uptake by crops and soil properties in the rice-rice pattern.

Materials and Methods

The experiment was carried out at the Research Farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during boro season of 2008-09. The soil belongs to Madhupur Tract (AEZ 28), Salna series and is fall the order of Inceptisols. A high yielding variety BRRIdhan29 was used as the test crop. The soil was silty clay loam mentioning porosity 48.50%, bulk density 1.29 g/cc, particle density 2.58 g/cc, pH 5.80, organic carbon 0.83%, total N 0.12%, available P 12.90 ppm, exchangeable K 0.52 meq./100 g soil and available S 12.98 ppm. Cowdung contained 0.82% N, 0.25% P, 0.50% K and 0.11% S, poultry manure 1.00% N, 0.30% P, 0.55% K and 0.16% S and urban wastes 0.80% N, 0.21% P, 0.45% K and 0.09% S. The randomized Complete Block design (RCBD) with three replications was used for the experiment. The unit plot size was 4.0 m × 2.5 m. Treatments were: T_0 = control, T_1 = 47.5: N:28P:57K:15 S Kg/ha, T_2 = 75: N:28P:57K:15 S Kg/ha, T_3 = 95:N:28P:57K:15S Kg/ha, T_4 = 47.5:N:13.63 P:28.3K:8.68 S Kg/ha + CD 5.75 t/ha, T_5 = 71.5:N:13.63 P:28.3K:8.68 S Kg/ha + CD 2.85 t/ha, T_6 = 47.5:N: 4.75 P Kg/ha + PM 4.75 t/ha, T_7 = 71.5:N:13.75 P:30.88 K:7.4 S Kg/ha + PM 2.37 t/ha, T_8 = 71.5:N:13.75 P:30.88 K:7.4: S Kg/ha + UW 5.75 t/ha, and T_9 = 71.5:N:9.75 P:30.50K:9.69 S Kg/ha + PM 2.85 t/ha,. Each treatment received equally 1.0 Zn Kg/ha and phosphorus, potassium and sulphur were adjusted where organic manures were applied. Recommended dose and fertilizer application method was used (FRG, 2005). Ninety five Kg N was used on 100% basis in treatment T_3 and subsequently 50% and 75% @ 47.5 and 71.7 Kg N/ha for treatment T_1 and T_2, respectively. Well decomposed poultry manure (PM), cowdung (CD) and Urban wastes (UW) were applied 25 and 50% basis of the recommended dose as per treatments one week before final land preparation. Nitrogen as urea was top dressed in three equal installments (splits) at 12, 35 and 58 days after transplanting. Thirty five days old seedlings were transplanted on 10 January, 2008. Distances of 20 cm from row to row and 15 cm from plant to plant were maintained. Intercultural operations like weeding and irrigations were done as and when necessary. The crops were harvested plot wise at maturity after 155 days in boro season (seed to seed). The analysis of variance for the crop characters and also the nutrient content of the plant samples were done following the ANOVA technique and the mean values were adjusted by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Nitrogen uptake by grain

The effect of different treatments on nitrogen uptake by grain is shown in Table 1. There was a significant variation among the treatments in respect of nitrogen uptake by grains.

The maximum nitrogen uptake by grains (63.16 kg/ha) of rice was observed in T_6 treatment receiving 47.50 kg N in combination with 9.50 t poultry manure/ha which was statistically superior to the rest of the treatments. The uptake of nitrogen by grain ranged from 27.52 to 63.16 kg/ha. However, nitrogen fertilizer in association with poultry manure, cowdung and urban wastes responded better than treatment receiving only nitrogen. Treatment T_6 recorded 129.50% higher nitrogen uptake than control treatment. The lowest nitrogen uptake (27.52 kg/ha) by grain was noted in control (T_0). These results are in agreement with the findings of Sharma and Mitra (1991). Azim (1999) and Hoque (1999) carried out experiments with organic manures and fertilizers together and found significantly higher N uptake in grain over control.

Phosphorus uptake

Phosphorus uptake by grain was significantly influenced by the application of chemical nitrogen fertilizer and organic manure viz. poultry manure, cowdung and urban wastes (Table 1). Phosphorus uptake by grain varied from 27.46 to 10.07 kg/ha and the maximum phosphorus uptake (27.46 kg/ha) was noted in the treatment T_6 (N_{50}+PM_{50}) which was significantly different to the rest of the treatments. However, all the treatments receiving chemical nitrogen fertilizer along with organic manures responded better than control treatment. The lowest phosphorus uptake (10.07 kg/ha) by grain was found in control treatment (T_0). Treatment T_6 produced 172.69% higher phosphorus uptake than control treatment. Gupta *et al.* (1995) reported the highest phosphorus uptake by rice with combined application of poultry manure (PM) and fertilizer phosphorus. Similar results were also reported by Hoque (1999) and Azim (1999).

Potassium uptake

A significant variation in potassium uptake by grain was observed due to the application of different levels of organic fertilizer along with organic manures (Table 1). The maximum potassium uptake by grain (13.17 kg/ha) was found by T_6 treatment receiving 47.50 kg N along with 9.50 t poultry manure/ha. The lowest potassium uptake by grain (4.73 kg/ha) was found in control (T_0) treatment. Treatment T_6 noted 178.43% higher potassium uptake than control treatment. The results of this experiment showed that potassium uptake by rice grain was increased due to the application of chemical nitrogen fertilizers along with manures. Cassman (1995) found that potassium uptake increased with the increasing organic matter. These results are in good agreement with Jagadeeswari *et al.* (2001) who reported increased potassium uptake in rice grain due to the application of cowdung along with NPK fertilizers.

Sulphur uptake

Sulphur uptake by grain was significantly influenced by different treatments of urea nitrogen and organic manures (Table 1). Sulphur uptake by rice grain was varied from 7.18 to 2.74 kg/ha. The highest sulphur uptake by grain (7.18 kg/ha) was observed by treatment T_6 (N_{50} + PM_{50}) which was statistically higher them to the rest of the treatments and the lowest sulphur uptake by grain (2.74 kg/ha) was found in control treatment. Treatment T_6 noted 162.04% higher sulphur uptake than control treatment. Poongothai *et al.* (1999) observed that application of suphur significantly enhanced sulphur uptake by rice. Islam *et al.* (1986) and Poongothai *et al.* (1999) reported that application of sulphur significantly increased sulphur uptake by rice.

Table1. Effects of urea nitrogen, cowdung, poultry manure and urban wastes on nitrogen, phosphorus, potassium and sulphur uptake by rice grain

Treatment	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)	S uptake (kg/ha)
T_0	27.52h	10.07f	4.73g	2.74i
T_1	45.11g	17.60e	9.62f	5.06h
T_2	47.25f	18.22e	10.06e	5.24g
T_3	49.06e	18.66e	10.30e	6.93b
T_4	57.82b	24.06b	12.44b	6.82b
T_5	51.03d	21.49cd	10.82d	5.90d
T_6	63.16a	27.46a	13.17a	7.18a
T_7	52.15c	22.37c	11.08c	6.18c
T_8	52.49c	22.12c	11.26c	6.17c
T_9	49.78e	20.62d	11.19c	5.82d
CV (%)	9.37	8.32	6.18	7.38

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by DMRT

Nitrogen uptake by straw

Chemical fertilizer along with poultry manure, cowdung and urban wastes significantly increased N uptake by straw compared to only nitrogen and control treatments (Table 2). The maximum N uptake of 43.01 kg/ha was noted in treatment T_6 receiving 47.50 kg N with the association of 9.50 t/ha poultry manure. Treatment T_6 receiving chemical nitrogen fertilizer along with 9.50 t poultry manure/ha produced 194.58% higher nitrogen uptake over control. The lowest value of N uptake by straw (14.60 kg/ha) was recorded in control (T_0) treatment.

Phosphorus uptake

Effect of nitrogen fertilizer and organic manures on phosphorus uptake by straw was significant (Table 2). Treatment T_6 receiving 47.50 kg N along with 9.50 t poultry manure/ha recorded the maximum P uptake (7.44 kg/ha) which was statistically superior to the rest of the treatments. The minimum P uptake by straw (3.37 kg/ha) was found in control. Treatment T_6 produced 120.77% higher phosphorus uptake by straw over control. This might be due to the application of chemical nitrogen fertilizer in association with organic manures which might have increased efficiency of phosphorus accumulation in straw result higher phosphorus uptake in straw. Chemical fertilizer along with poultry manure at the rate of 3 t/ha increased phosphorus uptake in rice (Anonymous, 2007a).

Potassium uptake

Potassium uptake by straw was significantly varied with different levels of chemical nitrogen fertilizer along with poultry manure, cowdung and urban wastes (Table 2). The maximum K uptake (68.44 kg/ha) by straw was found in T_6 treatment receiving 47.50 kg N along with 9.50 t/ha poultry manure. Chemical nitrogen with the combination of cowdung, poultry manure and urban wastage increased potassium uptake. Control treatment produced the minimum potassium uptake (37.05 kg/ha). Treatment T_6 produced 84.72% higher potassium uptake over control. Jagadeeswari *et al.* (2001) also observed that the potassium uptake by rice was increased by the application of organic manure with nitrogen, phosphorus and potassium. Chemical fertilizer with the association of poultry manure at the rate of 2 t/ha increased phosphorus uptake in rice (Anonymous, 2007b).

Sulphur uptake

The crop showed a good response to nitrogen fertilizer along with organic manure in recording S uptake by straw (Table 2). The highest sulphur uptake (7.07 kg/ha) was obtained by the treatment T_6 (N_{50} + PM_{50}) which was statistically significant to the rest of the treatments. Chemical nitrogen fertilizer in association with poultry manure (T_6) produced 139.66% higher nitrogen uptake over control. This might be due to the application of poultry manure, cowdung and urban wastes along with nitrogen fertilizer results comparatively better condition exploited more sulphur uptake by straw of BRRIdhan rice. The lowest sulphur uptake by straw (2.95 kg/ha) was found by control treatment.

Table 2. Effects of urea nitrogen, cowdung, poultry manure and urban wastes on nitrogen, phosphorus, potassium and sulphur uptake by rice straw

Treatment	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)	S uptake (kg/ha)
T_0	14.60g	3.37i	37.05f	2.95h
T_1	28.92f	5.38h	52.39e	5.14g
T_2	30.16e	5.64g	54.33d	5.33f
T_3	30.42e	5.74fg	54.76d	5.41ef
T_4	36.56b	7.13b	64.68ab	6.58b
T_5	30.67e	5.94ef	55.20d	5.64de
T_6	43.01a	7.44a	68.44a	7.07a
T_7	31.45d	6.14cd	56.22b	5.73cd
T_8	32.34c	6.30cd	57.36b	5.89cd
T_9	30.72e	6.03de	55.09d	5.60ef
CV (%)	6.75	8.23	9.21	4.65

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by DMRT

Effect on soil properties

Soil pH

The effects of urea nitrogen, poultry manure, cowdung and urban wastes on the pH values of the post-harvest soils have been presented in Table 3. The pH value of the post-harvest soils ranged from 5.9 to 6.1 as compared to initial pH value 5.8. All the treatments caused a decreasing effect on the pH value of the post harvest soils compared to the control but the values were inconsistent when compared with that of the initial soil. The decreasing effect was more where manures were applied. The lowest value of pH (5.90) was observed in T_6 and the highest value (6.10) was recorded in T_0 (control). The pH value of the post harvest soils decreased might be due to the organic acids released from the decomposition of organic manures. Swarup and Singh (1994) reported that the application of FYM decreased the soil pH compared with the control. Similar results were also observed by Kumar and Mishra (1991); Islam (1997) and Khan (1998).

Organic matter

The organic matter content of the post harvest soils was decreased due to application of fertilizers while results were reverse when manure were applied (Table 3). The organic matter content of the post harvest soils varied from 1.14 to 1.90 %. It was observed that organic matter content tended to increase in the soils treated with organic manures. The highest value of organic matter content (1.90%) was observed in the treatment T_6 and the lowest value (1.04%) in T_1 (N_{50}) treatment. Mathew and Nair (1997) reported that cattle manure alone or in combination with chemical fertilizer of NPK increased the organic carbon content.

Total Nitrogen

Total nitrogen content of post harvest soils varied is presented in Table 3. Soils treated with organic manure showed a slight increase in total N content of post harvest soils. Chemical fertilizers have a tendency to decrease the total N content in post harvest soils. The total nitrogen content of the post harvest soils ranged from 0.083 to 0.105 % as compared to the value of 0.063 of the initial soil and the highest value was observed in T_6. The results indicated that application of organic manures exerted an increasing effect on the total nitrogen content as well as the organic matter content of the post harvest soils. Rice cultivation with chemical fertilizers tended a decreasing effect on the organic matter and total N content of the soil. Mathew and Nair (1997) reported that organic manures increased the organic carbon, total N and available P content in soils.

Available Phosphorus

Post harvest soils were influenced slightly and inconsistently due to different treatments (Table 3). Available P of the post harvest soils ranged from 12.41 to 13.90 ppm against the P content of 12.9 ppm in initial soil. Available P of the post harvest soils increased slightly in all cases as compared to the initial soils except for the control. The highest and the lowest available P content were recorded in T_6 treatment. Soil treated with organic manures gave higher values of available P compared to other treatments. The release of available P from the decomposition of cowdung, poultry manure and urban wastes might be the cause of higher available P in soils treated with organic manures. Organic carbon, total N and available P content in soils increased due to application organic manures was reported by several workers (Sharma and Sharma, 1994 and Mathew and Nair, 1997).

Exchangeable Potassium

Due to application of chemical fertilizers and organic manures, exchangeable potassium content of the post harvest soils was also influenced. Potassium content in post-harvest soils ranged from 0.53 to 0.56 meq./100g soil (Table 3). Potassium content varied inconsistently and the application of cowdung, poultry manure and urban wastes caused a slight increase and K content over the initial value. It is also indicated that exchangeable K content was higher in soils treated with organic manures than those treated with chemical fertilizers. More (1994) observed that FYM and pressmud increased availability of N, P and K in soil.

Table 3. Effect of urea nitrogen, cowdung, poultry manure and urban wastes on the properties of the post harvest soils

Treatment	pH	Organic matter (%)	Total Nitrogen (%)	Available phosphorus (ppm)	Exchangeable potassium (meq/100g soil)	Available sulphur (ppm)
T_0	6.10	1.04	0.083	12.41	0.53	12.01
T_1	6.08	1.12	0.089	12.84	0.54	13.00
T_2	6.08	1.11	0.090	12.85	0.54	13.01
T_3	6.09	1.10	0.091	12.90	0.54	13.01
T_4	5.91	1.88	0.101	13.60	0.55	14.10
T_5	5.92	1.84	0.099	13.29	0.55	13.80
T_6	5.90	1.90	0.105	13.90	0.56	14.30
T_7	5.92	1.88	0.101	13.56	0.55	13.95
T_8	5.93	1.89	0.103	13.63	0.55	14.05
T_9	5.94	1.88	0.101	13.48	0.55	13.80

Available Sulphur

A little variation in available S content of post harvest soils due to different treatments (Table 3). Available S content of all the post harvest soils were found considerable higher as compared to the initial soils. The available S content of the post harvest soils ranged from 12.01 to 14.30 ppm. The highest value was recorded in T_6 treatment and the lowest value in T_0 treatment. Shahiduzzman (1997) reported that application of organic fertilizers increased available S content in soil compared to application of inorganic fertilizers.

Conclusion

Combined application of fertilizer along with cowdung, poultry manure and urban wastes performed better in respect of nutrient uptake by grain and straw than that of urea nitrogen alone. Nitrogen of the rate of 47.5 kg along with PKS and poultry manure at the rate of 9.5 t/ha performed best in most of the nutrient uptake by rice and straw. Among the organic sources, poultry manure performed best in nutrient uptake by rice. Organic manuring insignificantly increased organic matter, total N, available P, exchangeable K and available S contents in post harvest soil compared to initial soil. The result should that 47.5 kg N along with PKS and poultry manure at the rate of 4.75t/ha may be suitable dose for higher yield of boro rice. Cowdung or urban wastes at the rate of 5.75 t/ha, respectively could be applied in boro rice if poultry manure is not available.

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